Model M3500DB

Dynamic Safety Brake for Servo Motors

Customer Reference Manual

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Bonitron, Inc.
Nashville, TN

An industry leader in providing solutions for AC drives.

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With engineering, production, and testing all in the same facility, Bonitron is able to ensure its products are of the utmost quality and ready to be applied to your application.

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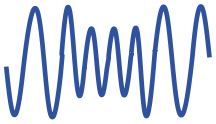
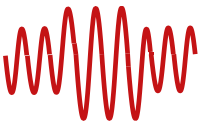


Undervoltage Solutions

Uninterruptible Power for Drives
(DC Bus Ride-Thru)
Voltage Regulators
Chargers and Dischargers
Energy Storage



Overvoltage Solutions

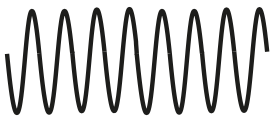
Braking Transistors
Braking Resistors
Transistor/Resistor Combo
Line Regeneration
Dynamic Braking for Servo Drives

Common Bus Solutions

Single Phase Power Supplies
3-Phase Power Supplies
Common Bus Diodes

Portable Maintenance Solutions

Capacitor Formers
Capacitor Testers



Power Quality Solutions

12 and 18 Pulse Kits

Green Solutions

Line Regeneration

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1. INTRODUCTION

1.1. WHO SHOULD USE

This manual is intended for use by anyone who is responsible for integrating, installing, maintaining, troubleshooting, or using this equipment with any motion control system.

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

This manual is a user's guide for the model M3500DB and M3500DB4 dynamic braking modules for E-Stop applications. It will provide you with the necessary information to successfully install, integrate, and use the M3500DB and M3500DB4 modules in any motion control system.

In the event of any conflict between this document and any publication and/or documentation related to the AC drive system, the latter shall have precedence.

1.3. MANUAL VERSION AND CHANGE RECORD

Specifications were updated in Rev 13 of this manual.

Additional dimensions were added in Rev 13a.

Deceleration time calculation was added in Section 7 in Rev 13b.

Information regarding the 65A and 150A models was added in Rev 14.

65A module availability was updated in Rev 14a.

EN-954 product ratings were updated in Rev 14b.

Updates made to MPL-B series motor cross reference table in Rev 14c.

Figure 3-8 was updated in Rev 14d.

Figure 3-2 was updated in Rev 14e.

Table 6- was updated in Rev 14f.

Figure 1-1: M3500DB-H03A-65

1.4. SYMBOL CONVENTIONS USED IN THIS MANUAL AND ON EQUIPMENT

	Earth Ground or Protective Earth
	AC Voltage
	DC Voltage
 DANGER!	DANGER: Electrical hazard - Identifies a statement that indicates a shock or electrocution hazard that must be avoided.
 DANGER!	DANGER: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.
 CAUTION!	CAUTION: Identifies information about practices or circumstances that can lead to property damage, or economic loss. Attentions help you identify a potential hazard, avoid a hazard, and recognize the consequences.
 CAUTION!	CAUTION: Heat or burn hazard - Identifies a statement regarding heat production or a burn hazard that should be avoided.

2. PRODUCT DESCRIPTION / FEATURES

The M3500DB dynamic braking module is designed to provide resistive E-stop braking control for permanent magnet servo motion systems with safety requirement as per EN-954. The M3500 brake module incorporates positive guided contactors and can be used in conjunction with a control reliable safety relay to provide the desired level of system safety.

In order to achieve redundancy, as in EN-954, the drive is the primary brake, and must always attempt to stop the axis (controlled stop) upon E-stop or light curtain command. Regenerative braking may be needed in order to achieve a safe decel time. The M3500DB4 is the secondary brake, and will stop the motor in case of power or motion controller failure.

This document describes the model M3500DB and M3500DB4 series of dynamic safety brake modules for E-Stop applications.

The M3500DB and M3500DB4 dynamic safety brake modules are compatible with any servo system and are designed for use in conjunction with regenerative braking for E-stop applications. These modules enhance system performance and safety by providing resistive braking control for emergency stop applications when regenerative braking fails.

The dynamic safety brake will satisfy three basic functions as outlined below:

- The need to physically isolate one motor from its drive on a very frequent basis so that the axis module is in a safe condition for an operator to intervene in a process. The system module and other Servo modules remain "live".
- To act as a back-up brake in E-stop situations where an operator has tripped a light curtain or other safety interlock device.
- To act as a back-up brake to slow a servo in case of a power loss or a malfunction which prevents the use of regenerative braking in an emergency stop situation.

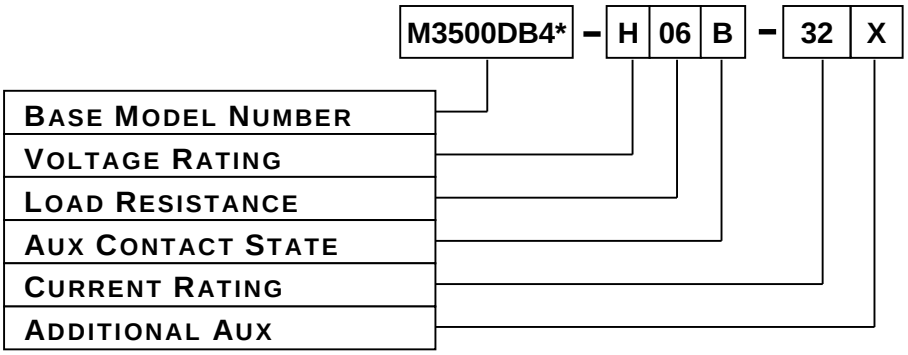
Both the M3500DB and M3500DB4 modules can be run right out of the box. However, these modules also provide the user a measure of control via selectable contactor brake delay time settings to allow custom integration into existing safety schemes.

All model M3500DB and M3500DB4 dynamic safety brake modules are designed for use in 380/460 VAC rated systems using any available permanent magnet servo-motors. The modules utilize safety class-2, positive guided contactors to stop an axis module on command. Refer to Section 7 at the end of this manual for easy motor-to-module cross-referencing.

The standard M3500DB dynamic safety brake module conforms to category II safety requirements per EN-954. The model M3500DB4 incorporates redundant, positive guided contactors to satisfy category IV safety requirements per EN-954.

2.1. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER*

The Base Model Number for the standard dynamic safety brake is **M3500DB**. The standard module meets category II safety requirements per EN-954.

Model number **M3500DB4** should be used if redundant, positive-guided braking contactors are needed to satisfy category IV safety requirements in accordance with EN-954.

MAXIMUM VOLTAGE RATING

The standard AC voltage rating for Model M3500DB and M3500DB4 dynamic safety brake modules uses the letter **H**. These modules are intended for systems with a maximum of 460VAC input line voltage. Lower voltages can be used.

LOAD RESISTANCE

The load resistance rating indicates the internal load resistance of the braking module. For instance, a number **06** in the part number would indicate that the module has a load resistance of 6Ω per leg in a wye configuration.

See section 6 for available part numbers.

AUXILIARY CONTACT STATE

The 32A and 43A units in both M3500DB and M3500DB4 dynamic safety brake modules are available with either a normally open (NO) or normally closed (NC) auxiliary contact output on each braking contactor for monitoring contactor status. The terms normally open and normally closed refer to the state of the auxiliary contact when the braking contactor is in a de-energized condition. This can occur with the loss of power or while in brake mode.

A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.

A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

The 65A and 150A units provide both auxiliary contacts (NC and NO) for each power contact, and therefore it only uses the **A** in this position.

CURRENT RATING

The current rating indicates the maximum FLA rating of the braking module's internal braking contactor(s). The number **32** in the part number would indicate that the module's braking contactors are rated for 32 full load amps.

See Section 6 for available part numbers.

ADDITIONAL AUXILIARY CONTACTS

An **X** in this position indicates that the signal filtering option is exchanged for an extra set of auxiliary contacts on the contactors. For the DB4 module, each contactor has an independent set of contacts.

2.2. GENERAL SPECIFICATIONS

Table 2-1: General Specifications

PARAMETER	SPECIFICATION
Max AC Voltage	480 VAC at rated current
Max FLA	32 A 43 A 65 A 150 A
Lifetime Cycles	1,000,000 (no load)
Operation Rate	3 Full Load Stops/Hour
Switching Delay	35-70 ms
Aux. Contact	250 VAC, 2 A
Storage Temp	-20°C to +65°C
Humidity	Below 90 % non-condensing
Atmosphere	Free of corrosive gas and conductive dust

2.3. General Precautions and Safety Warnings

DANGER!

- High voltages may be present!
- Never attempt to operate this product with the enclosure cover removed!
- Never attempt to service this product without first disconnecting power to and from the unit!
- Always allow ample time for residual voltages to drain before removing the enclosure cover.
- **Failure to heed these warnings may result in serious injury or death!**

CAUTION!

- This product will generate high temperatures during operation.
- This product should be installed accordingly on non-flammable surfaces with clearances of at least four inches in all directions.
- Always allow ample time for the unit to cool before attempting service on this product.
- Before attempting installation or removal of this product, be sure to review all drive and/or resistive load documentation for pertinent safety precautions.
- Installation and/or removal of this product should only be accomplished by a qualified electrician in accordance with National Electrical Code or equivalent regulations.
- When working with shielded cables, special care should be taken to not nick or cut other wires in the cable. Ensure shield does not have stray strands that can accidently come in contact with electrical equipment.

ANY QUESTIONS AS TO APPLICATION, INSTALLATION, OR SERVICE SAFETY SHOULD BE DIRECTED TO THE EQUIPMENT SUPPLIER OR SPECIFYING ENGINEER.

3. INSTALLATION INSTRUCTIONS

This section provides all of the information needed to physically mount the model M3500DB and M3500DB4 series of dynamic safety brake modules.

3.1. ENVIRONMENT

When selecting the installation site for the model M3500DB or M3500DB4 braking module, be sure there is ample space to allow for a minimum of 4 inches of clearance above and below the module.

This is to allow for proper air flow through the module in order to dissipate any heat generated during the braking process.

3.2. UNPACKING

Upon receipt of this product, please verify that the product received matches the product that was ordered and that there is no obvious physical damage to the unit. If the wrong product was received or the product is damaged in any way, please contact the supplier from which the product was purchased.

3.3. MOUNTING

3.3.1. BONDING

Bonding is the practice of connecting or mounting the various modules, assemblies, panels, shields, and enclosures of a system in such a way as to reduce the effects of electromagnetic interference (EMI).

When done properly, bonding provides a low impedance path for high frequency energy to exit an enclosure or system. If not dealt with, excessive high frequency energy can damage or affect the operation of nearby electronic equipment.

Model M3500DB dynamic safety brake modules are plated with zinc chromate. This provides the modules with an electrically conductive finish, allowing for excellent bonding. Be sure the module has good contact with earth ground to ensure proper shielding.

3.3.2. MOUNTING THE M3500DB(4) DYNAMIC SAFETY BRAKE

The 32A and 43A modules are mounted using (2) M6 or ¼" mounting screws. The 65A and 150A modules are mounted using (4) M6 or ¼" mounting screws. Refer to Figures 6-2 and 6-3 for mounting dimensions. Allow for 4" of clearance above and below the module for adequate ventilation. Threaded ground terminals accepting M4 screws are available for cable shield grounding clamps. Motor ground wires should terminate at TS1 & TS2.

Figure 3-1: Field Connections for 32A & 43A M3500DB(4) Modules

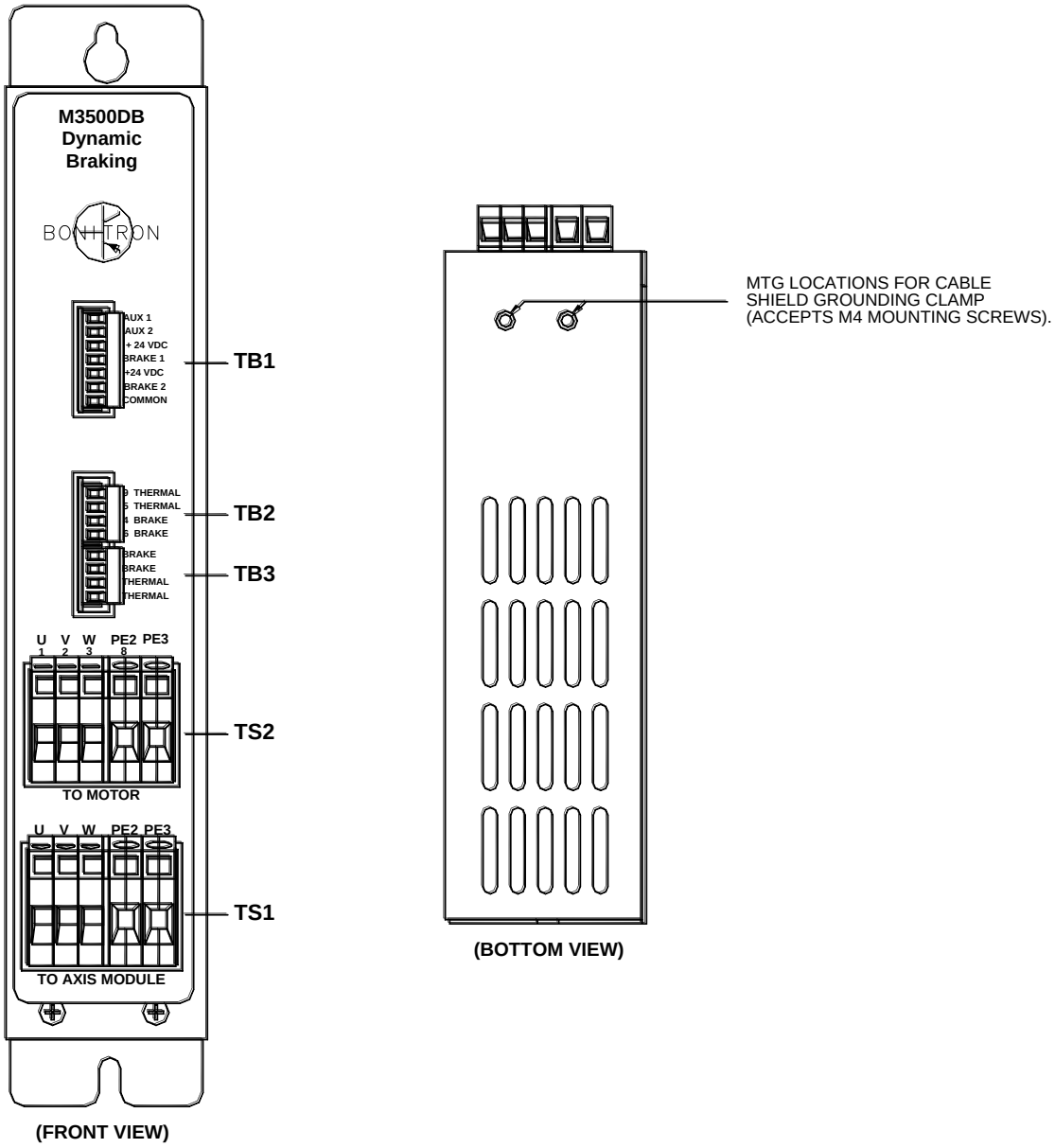


Figure 3-2: Field Connections for 65A M3500DB Modules

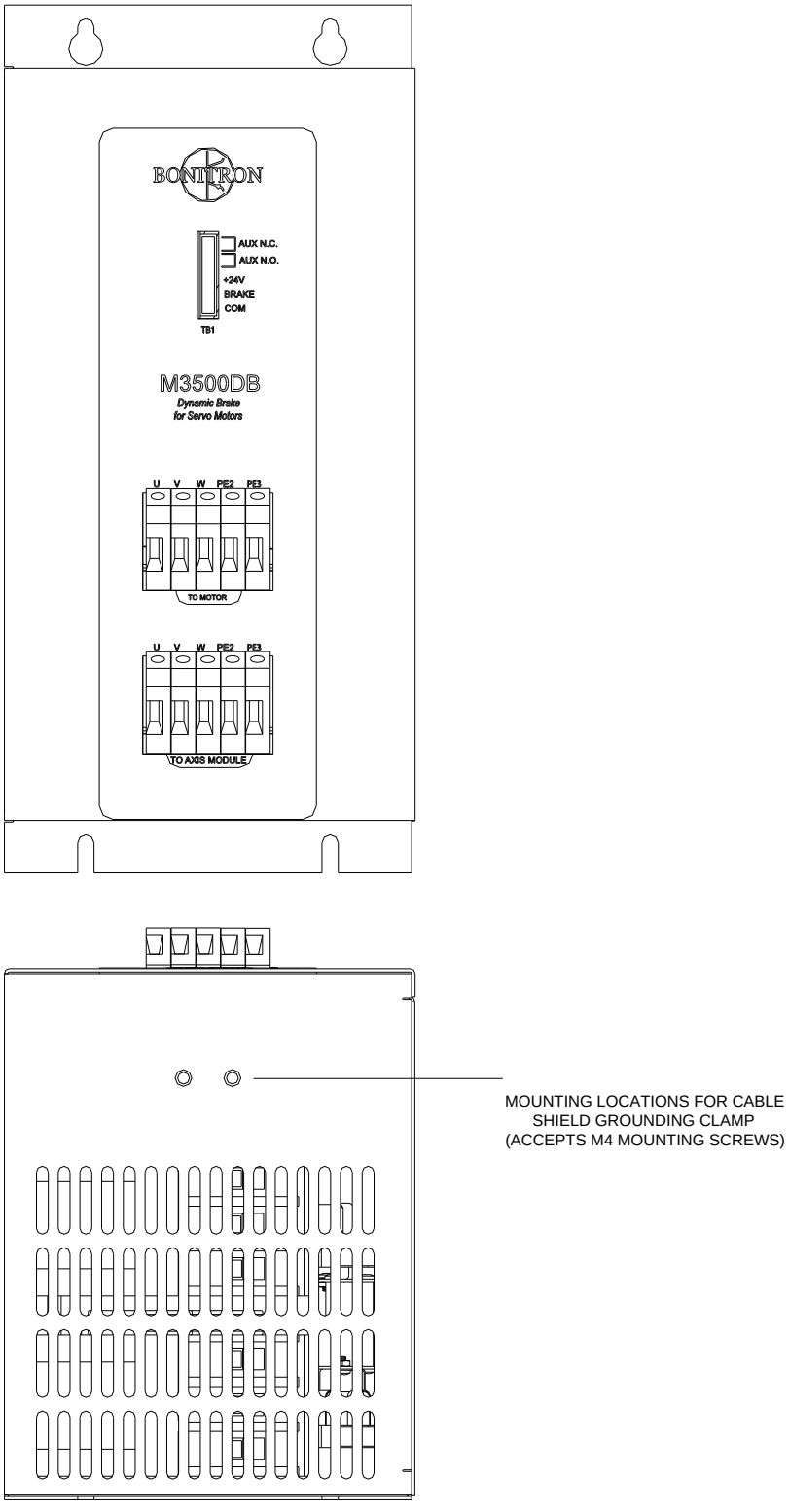
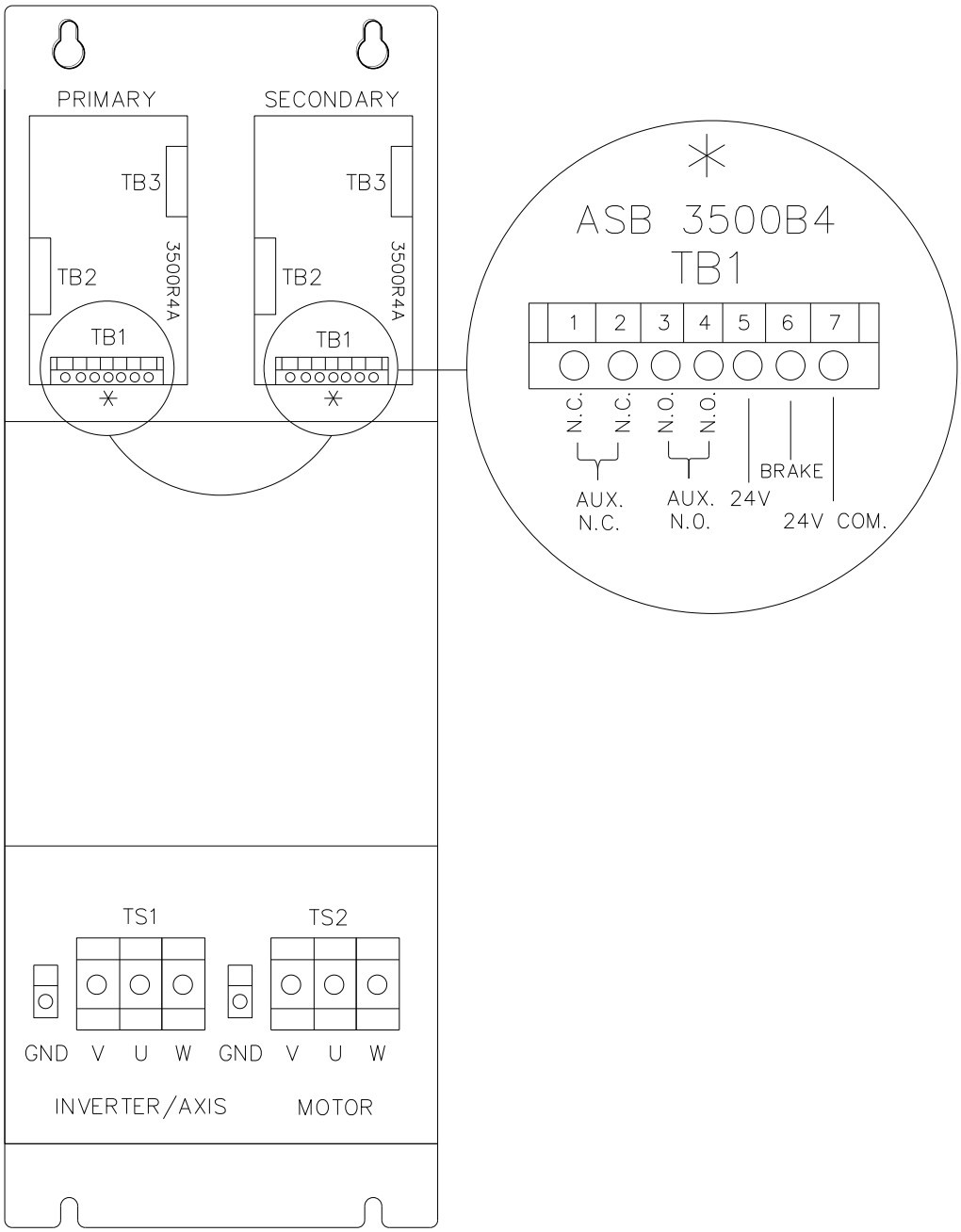


Figure 3-3: Field Connections for 150A M3500DB4 Modules



3.4. WIRING AND CUSTOMER CONNECTIONS

3.4.1. POWER WIRING

Table 3-1: 32A & 43A Power Terminations

POWER SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TS1-1	Servo Drive	U1	Servo Controller	8 AWG	10 lb-in	Lower SAK6N terminals located near bottom of module front panel	3-phase PWM from drive
TS1-2		V1					
TS1-3		W1					
TS1-4	Ground	PE2		10 AWG			Ground
TS1-5		PE3					
TS2-1	Servo Motor	U1	Motor	8 AWG	10 lb-in	Upper SAK6N terminals located in lower middle of module front panel	3-phase PWM to motor
TS2-2		V1					
TS2-3		W1					
TS1-4	Ground	PE2		10 AWG			Ground
TS1-5		PE3					

Table 3-2: 65A Power Terminations

POWER SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TS1-1	Servo Drive	U1	Servo Controller	6 AWG	30 lb-in	Lower SAK16 terminals located near bottom of module front panel	3-phase PWM from drive
TS1-2		V1					
TS1-3		W1					
TS1-4	Ground	PE2		8 AWG			Ground
TS1-5		PE3					
TS2-1	Servo Motor	U1	Motor	6 AWG	30 lb-in	Upper SAK16 terminals located in lower middle of module front panel	3-phase PWM to motor
TS2-2		V1					
TS2-3		W1					
TS1-4	Ground	PE2		8 AWG			Ground
TS1-5		PE3					

Threaded inserts using M4 screws are available on underside of module for ground shield cable clamps.

Table 3-3: 150A Power Terminations

POWER SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TS1-1	Servo Drive	U1	Servo Controller	2 / 0	110 lb-in	Bottom of module on left side	3-phase PWM from drive
TS1-2		V1					
TS1-3		W1					
TS1-4	Ground	PE					Ground
TS2-1	Servo Motor	U1	Motor	2 / 0	110 lb-in	Bottom of module on right side	3-phase PWM to motor
TS2-2		V1					
TS2-3		W1					
TS1-4	Ground	PE					Ground

3.4.1. CONTROL WIRING

When wiring the M3500DB and M3500DB4 Dynamic Safety Brake for control, it is important to be familiar with the control scheme of the entire system. Be sure to review all relevant system documentation before attempting to make these connections. Please note that in order to achieve a safety class 2 or 4 system, the M3500DB and M3500DB4 Braking modules must be used in conjunction with a safety relay.

Table 3-4: Control Terminations for 32A & 43A Models

CONTROL SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TB1-1	AUXILIARY Contact	AUX	Control circuits	14 AWG	4.5 lb-in	Upper plug located on module front panel	Brake Status Report
TB1-2		AUX					
TB1-3	+24V Enable1	EN1	24V power supply				Precharge
TB1-4	+24V Brake1	BR1	Control circuits				Brake
TB1-5	+24V Enable2	EN2	24V power supply				Precharge
TB1-6	+24V Brake 2	BR2	Control circuits				Brake
TB1-7	Common	COM	24V power supply				Common
TB2-1	Therm 1	K1	Servo Motor	14 AWG	4.5 lb-in	Middle plug located on module front panel	Temp Feedback
TB2-2		K2					
TB2-3	Brake 1	B1					Mechanical Brake Coil
TB2-4		B2					
TB3-1	Brake 2	B2	Servo Controller	14 AWG	4.5 lb-in	Lower plug located on module front panel	Mechanical Brake Coil
TB3-2		B1					
TB3-3	Therm 2	K2					Temp Feedback
TB3-4		K1					

Table 3-5: Control Terminations for 65A Models

CONTROL SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TB1-1	AUXILIARY N.C. Contact	AUX N.C.	Control circuits	14 AWG	4.5 lb-in	Top half of unit on TB1	Brake Status Report
TB1-2							
TB1-3	AUXILIARY N.C. Contact	AUX N.O.	Control circuits				Brake Status Report
TB1-4							
TB1-5	+24V Enable	EN	24V power supply		4.5 lb-in		Precharge and Power
TB1-6	+24V Brake	BR	Control circuits				Brake
TB1-7	Common	COM	24V power supply				Common

Table 3-6: Control Terminations for 150A Models

CONTROL SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TB1-1	AUXILIARY N.C. Contact	AUX N.C.	Control circuits	14 AWG	4.5 lb-in	Top half of unit on ASB 3500R4	Brake Status Report
TB1-2							
TB1-3	AUXILIARY N.C. Contact	AUX N.O.	Control circuits				Brake Status Report
TB1-4							
TB1-5	+24V Enable	EN	24V power supply				Precharge and Power
TB1-6	+24V Brake	BR	Control circuits				Brake
TB1-7	Common	COM	24V power supply				Common

3.4.1.1. GROUNDING REQUIREMENTS

There are three ground connection points (motor input, motor output, and cable shield) all tied to chassis. The chassis is plated with zinc chromate to help keep EMI inside in the 65A and below models.

The chassis should be earth grounded at one of these connection points in accordance with local codes and EMI practices.

3.5. TYPICAL CONFIGURATIONS

Figure 3-4: M3500DB 32A & 43A Basic Control Circuit Interconnection with B1, B2 Filtering

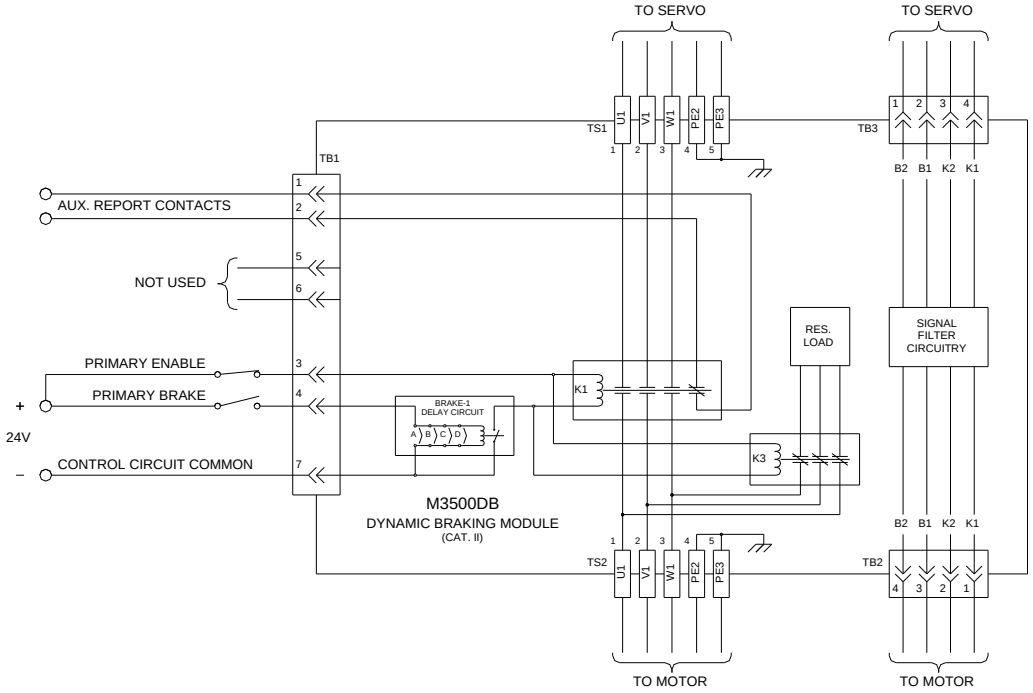


Figure 3-5: M3500DB4 32A & 43A Basic Control Circuit Interconnection with B1, B2 Filtering

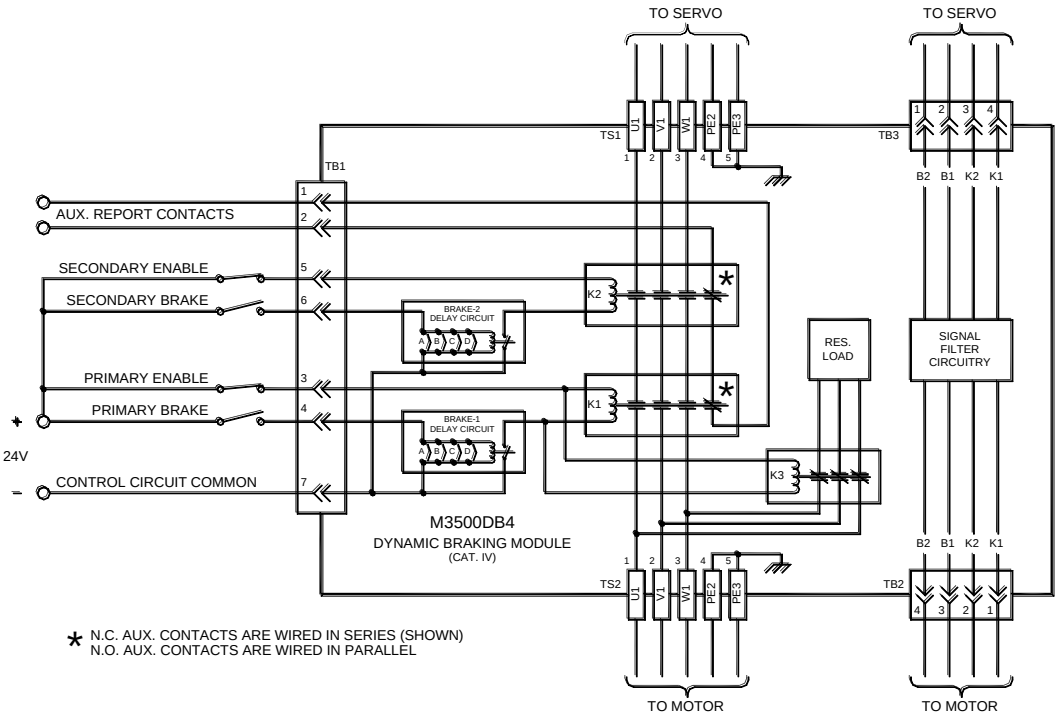


Figure 3-6: M3500DB 32A & 43A Basic Control Circuit Interconnection with "X" Option

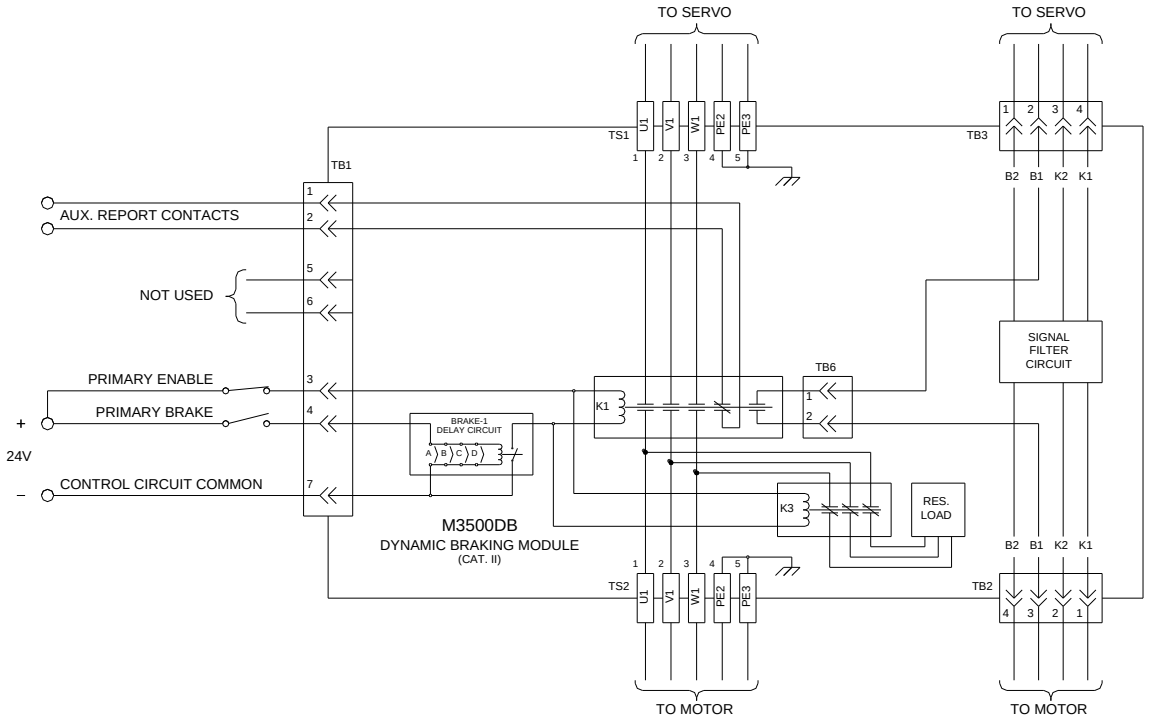


Figure 3-7: M3500DB4 32A & 43A Basic Control Circuit Interconnection with "X" Option

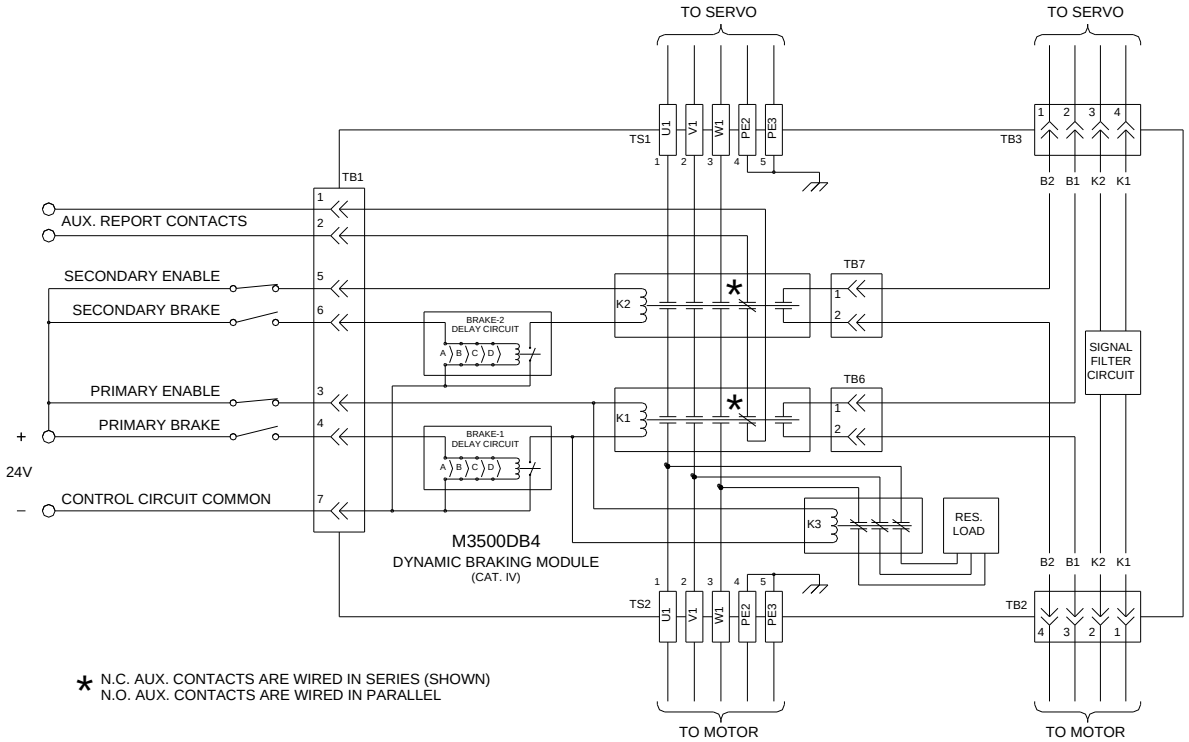


Figure 3-8: M3500DB 65A Basic Control Circuit Interconnection

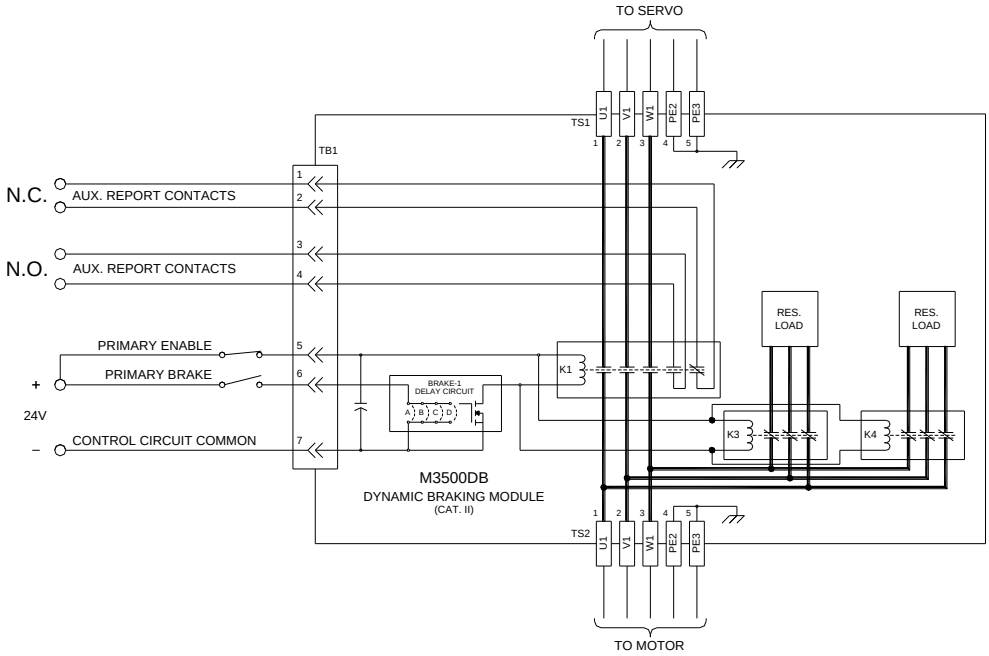
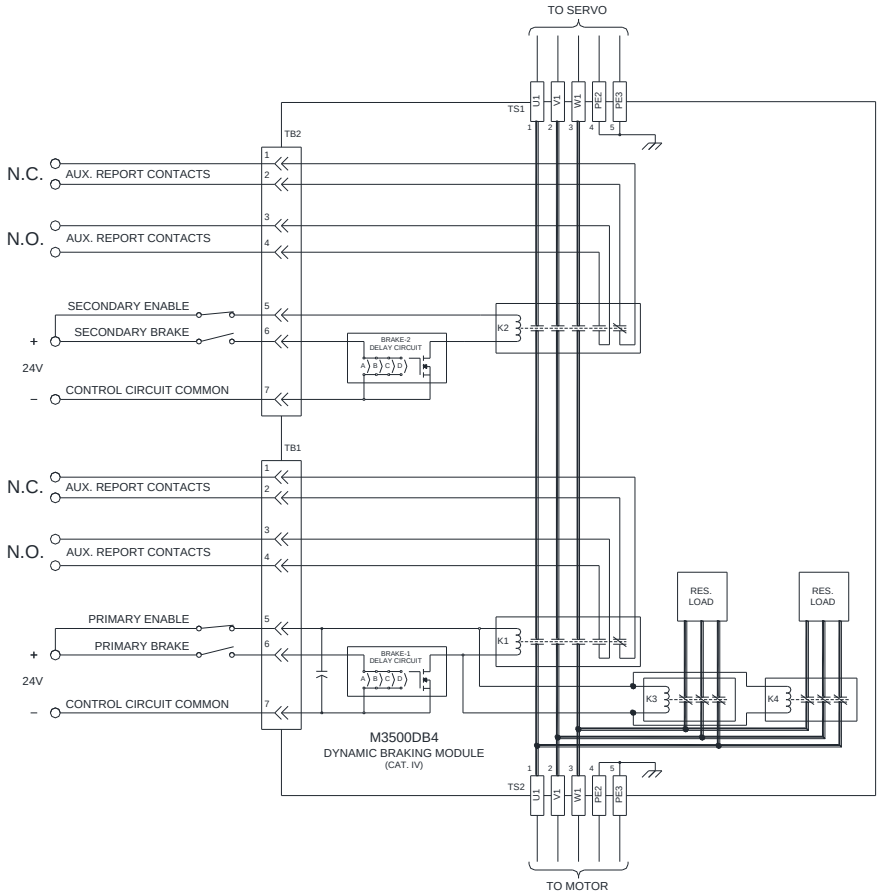


Figure 3-9: M3500DB4 150A Basic Control Circuit Interconnection



4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3500DB Dynamic Braking Module was designed to be used as an integral part of a complete safety system, as per EN 954-1. The M3500DB module is designed to provide resistive e-stop braking control as a backup to the normal stopping process, so that inverter failure or power failure cannot result in the loss of safety. The system should be designed so that if power is removed, or if the servo drive doesn't decelerate in time, the DB Module will disconnect the servo drive and motor, then place resistance across the motor windings for emergency stopping.

The DB Module switches the servo drive output with a contactor. The contactor is controlled by a dry "brake" contact from the motor control system. When the "brake" command is received, a selectable time delay ranging from 0 to 2 seconds begins, allowing for controlled decelerate of the motor. When the time delay is over, the contactor disconnects the motor from the servo drive, and resistance is applied to the motor output.

The braking delay times are jumper selectable in half-second increments, and adjustable in between those increments. The module comes factory set for a 0.5 second delay.

In some models, filtering is also provided for mechanical brake and thermal signals to and from the motors.

4.2. FEATURES

4.2.1. INPUTS

4.2.1.1. PRIMARY ENABLE INPUT (M3500DB AND M3500DB4)

The PRIMARY ENABLE input supplies the coil voltage for primary contactor K1. This signal must be present for the servo drive to power the motor.

Losing or removing this signal will cause contactor K1 and K3 to drop out (immediately for 32A and 43A units, after a 2 second delay for the 65A and 150A units). Upon dropping out, the motor will be disengaged, and the resistive braking load will be applied. NOTE: Primary Enable should NOT be relied upon to provide instant drop out of contactor. Use Primary Brake with zero delay or use the M3500DB4 model.

4.2.1.2. PRIMARY BRAKE INPUT (M3500DB AND M3500DB4)

The PRIMARY BRAKE input supplies the coil voltage for the primary contactor brake relay. This signal must be present for the primary contactor to be energized.

Losing or removing this signal will initiate the brake time delay. Once the time delay has expired, contactor **K1** and **K3** will drop out, the motor will be disengaged, and the braking load will be applied. For more details on the brake delay circuit, see Section 4.4.1 of this manual.

4.2.1.3. SECONDARY ENABLE INPUT (M3500DB4 ONLY)

The SECONDARY ENABLE input supplies the coil voltage for secondary contactor **K2**. This signal must be present for the Axis to power the Servo-motor. Losing or removing this signal will cause contactor **K2** to drop out. (Immediately for 32A and 43A units, after a 2 second delay for

the 150A units). Upon dropping out, the motor will be disengaged without applying the braking load.

4.2.1.4. SECONDARY BRAKE INPUT (M3500DB4 ONLY)

The SECONDARY BRAKE input supplies the coil voltage for the secondary contactor brake relay. This signal must be present for the secondary contactor to be energized.

Losing or removing this signal will initiate the brake time delay. Once the time delay has expired, contactor K2 will drop out and the motor will be disengaged without applying the braking load. For more details on the brake delay circuit, see Section 4.4.1 of this manual.

4.2.2. OUTPUTS

4.2.2.1. AUX. REPORT CONTACT (M3500DB AND M3500DB4)

The AUX. REPORT CONTACT output is used to monitor the status of the primary and/or secondary contactors. The de-energized state of this contact is determined by the Braking module part number. A letter **A** after the load resistance value in the part number indicates that the module is supplied with **Normally Closed** (N.C.) Aux. contact outputs while a letter **B** indicates that the module is supplied with **Normally Open** (N.O.) Aux. contact outputs.

For all M3500DB4 32A and 43A models, which have dual contactors, normally closed auxiliary contact outputs are wired in a series configuration while normally open auxiliary contact outputs are wired in a parallel configuration.

These contacts are factory hard-wired based on the part number. However, if necessary, the contacts can be reconfigured. Figure 4-1 in the “Brake Delay Settings” section (Section 4.4.1) of this manual shows the locations of the internal contact terminations.

The 65A and 150A modules supply both the N.O. and N.C. contacts at TB1.

AUXILIARY CONTACT NOTES

- The Truth Tables (Table 4-1 and Table 4-2) represent all possible combinations of control circuit inputs and the resulting auxiliary contact states of both the normally open and normally closed contacts for M3500DB and M3500DB4 Dynamic Safety Brake modules.
- All control circuits require a regulated +24V DC input or a closed +24V DC circuit for proper operation.
- The terms Normally Open (N.O.) and Normally Closed (N.C.) refer to a contact’s state while the contactor’s coil is de-energized.
- For the Model M3500DB4, N.O. contacts are wired in parallel and N.C. contacts are wired in series. The 150A module supplies both the N.O. and N.C. contacts at TB1.
- For the Model M3500DB4, combinations 13, 14, and 15 in Table 4-2 will allow the possibility of “Open” or disconnected motor outputs at TS2 of the Braking module without the module’s internal braking load connecting to the motor.

4.2.2.2. ADDITIONAL AUX CONTACTS

When the Additional Auxiliary Contact option (X) is built, the B1 and B2 brake signal path is interrupted by a second AUX contact on each main motor contactor. B1 is interrupted by the primary contactor on DB and DB4 units, while B2 is interrupted by the secondary contactor. This option is factory hard wired based on the part number. Figures 3-6 and 3-7 show the basic schematic with this option installed.

The truth table for M3500DB modules can be found in Table 4-1, and for M3500DB4 modules in Table 4-2.

4.2.3. TRUTH TABLES

Table 4-1: M3500DB Auxiliary Contact Status and Control Logic Truths

COMBINATIONS	CONTROL CIRCUITS (+24V DC)				MOTOR STATUS		(A) CONTACT STATUS		(B) CONTACT STATUS	
	Primary Enable-1	Primary Brake-1	Secondary Enable-2	Secondary Brake-2	U1,V1,W1 Output To Motor	Braking Resistors Engaged	AUX Contact N.C.	B1 Contact N.O. "X" Option	AUX Contact N.O.	B1 Contact N.C. "X" Option
1	Open	Open	Not Used	Not Used	No	Yes	Closed	Open	Open	Closed
2	Open	Closed	Not Used	Not Used	No	Yes	Closed	Open	Open	Closed
3	Closed	Open	Not Used	Not Used	No	Yes	Closed	Open	Open	Closed
4	Closed	Closed	Not Used	Not Used	Yes	No	Open	Open	Closed	Closed

Table 4-2: M3500DB4 Auxiliary Contact Status and Control Logic Truths

COMBINATIONS	CONTROL CIRCUITS (+24V DC)				MOTOR STATUS		(A) CONTACT STATUS			(B) CONTACT STATUS		
	Primary Enable-1	Primary Brake-1	Secondary Enable-2	Secondary Brake-2	U1,V1,W1 Output To Motor	Braking Resistors Engaged	AUX Contact N.C.	B1 Contact N.O. "X" Option	B2 Contact N.O. "X" Option	AUX Contact N.O.	B1 Contact N.C. "X" Option	B2 Contact N.C. "X" Option
1	Open	Open	Open	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
2	Open	Open	Open	Closed	No	Yes	Closed	Open	Open	Open	Closed	Closed
3	Open	Open	Closed	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
4	Open	Open	Closed	Closed	No	Yes	Open	Open	Closed	Closed	Closed	Open
5	Open	Closed	Open	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
6	Open	Closed	Open	Closed	No	Yes	Closed	Open	Open	Open	Closed	Closed
7	Open	Closed	Closed	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
8	Open	Closed	Closed	Closed	No	Yes	Open	Open	Closed	Closed	Closed	Open
9	Closed	Open	Open	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
10	Closed	Open	Open	Closed	No	Yes	Closed	Open	Open	Open	Closed	Closed
11	Closed	Open	Closed	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
12	Closed	Open	Closed	Closed	No	Yes	Open	Open	Closed	Closed	Closed	Open
13	Closed	Closed	Open	Open	No	No	Open	Closed	Open	Closed	Open	Closed
14	Closed	Closed	Open	Closed	No	No	Open	Closed	Open	Closed	Open	Closed
15	Closed	Closed	Closed	Open	No	No	Open	Closed	Open	Closed	Open	Closed
16	Closed	Closed	Closed	Closed	Yes	No	Open	Closed	Closed	Closed	Open	Open

4.3. STARTUP

4.3.1. PRE-POWER CHECKS

1. Confirm that proper DB module is used. See motor charts in Section 7 of this manual. (Note that not all motors are listed.)
2. Ensure that M3500DB module is properly installed as per instructions in Section 3 of this manual.

4.3.2. STARTUP PROCEDURE AND CHECKS

Model 3500DB is designed as a disconnect and brake for servo motor applications. It is to be controlled by a special safety relay and becomes part of an overall motor control safety system. This start -up procedure describes what to expect from the M3500DB unit, and does not consider other aspects of the connected system.

1. Apply 24VDC power to the Enable input of each contactor to be controlled.
   - DB models use only the PRIMARY enable.
   - DB4 models use the PRIMARY and SECONDARY enables.
   - For the 65A and 150A models, allow 10 seconds to precharge the surge capacitor before applying the brake signal in step 2.
     a) Aux report contact should not change states.
2. After a 10 second precharge time, apply the 24VDC PRIMARY brake signal(s) to each contactor to be controlled.
   - DB models use only the PRIMARY brake.
   - DB4 models use the PRIMARY and SECONDARY brake.
     a) PRIMARY contactor will pull in immediately when primary brake signal is applied.
     b) SECONDARY Contactor will pull in immediately when secondary brake signal is applied.
     c) Aux report contact should change states once all contactors are pulled in.
3. Remove the PRIMARY brake signal.
   a) Primary contactor will drop out after programmed time delay.
   i. Time delay can be defeated or changed by internal jumpers.
   b) Aux report contact changes when contactor drops out (after delay).
4. Remove the SECONDARY brake signal.
   a) Secondary contactor will drop out after programmed time delay.
   i. Time delay can be defeated or changed by internal jumpers.
5. Reapply brake signals.
   a) Contactors will pull in when brake signal is applied.
   b) Aux report contact changes once all brake signals are applied and contactors are pulled in.

4.4. OPERATIONAL ADJUSTMENTS

4.4.1. BRAKE DELAY SETTINGS

The Model M3500DB and M3500DB4 Dynamic Safety Brakes are provided with contactor brake delay timing on the **PRIMARY BRAKE** and **SECONDARY BRAKE** input signals to ensure proper shutdown sequencing. The brake delay initiates upon loss of the **BRAKE** input signal. Once the delay has timed out, the brake relay will deactivate causing the corresponding contactor to drop out. **All modules are factory preset with a brake delay time of 0.5-second.**

It is important to note that the **PRIMARY ENABLE** and **SECONDARY ENABLE** inputs **do not** have a delay on 32A and 43A models. Loss of an **ENABLE** signal will cause the corresponding contactor to drop out immediately. 65A and 150A models have a 2 second drop out delay after **ENABLE** is removed.

65A models have a separate delay that matches internal relay drop out times. IF K3 dumps the load resistor on the motor BEFORE the path from the drive is opened, drive IOC faults may occur. This internal drop out delay is factory set for 20ms and should not be adjusted unless IOC faults occur.

4.5. CALIBRATION

Brake delay times are calibrated based on a 24.0VDC Brake signal input. These times are accurate to within ±5% for the required 20-28VDC input voltage range.

Brake delay times can be adjusted by approximately 250 milliseconds up or down from the jumper settings. Adjusting the pot in a clockwise direction will increase the brake delay setting while a counter-clockwise adjustment decreases the delay. Each turn of the adjustment screw will give approximately 50 milliseconds.

To make adjustments to the delay setting you must first remove the cover panel from the right side of the braking module for 65A units or the front cover for 150A units. Once this is done, the delay jumpers and adjustment pots are accessible. Next, set the delay jumpers to the setting that comes closest to the desired delay time. Now calculate the difference between the desired delay time and the jumper setting to determine the amount of adjustment needed.

For example, suppose that a brake delay of 1.6 seconds is desired. You would first set the delay jumpers for 1.5 seconds. Then, we calculate the difference between the desired delay time and the jumper setting. In this case, it is 0.1 seconds or a 100 millisecond increase. Two turns of the pot will be needed (approx. 50 milliseconds/turn) for a 100 millisecond adjustment. For an increase, the adjustment must be made in a clockwise direction.

Please note that the 50 millisecond/turn specification given above is only an approximation to aid in the calibration of the brake delay setting. Repeated adjustments may be required in order to fine tune the brake delay setting.

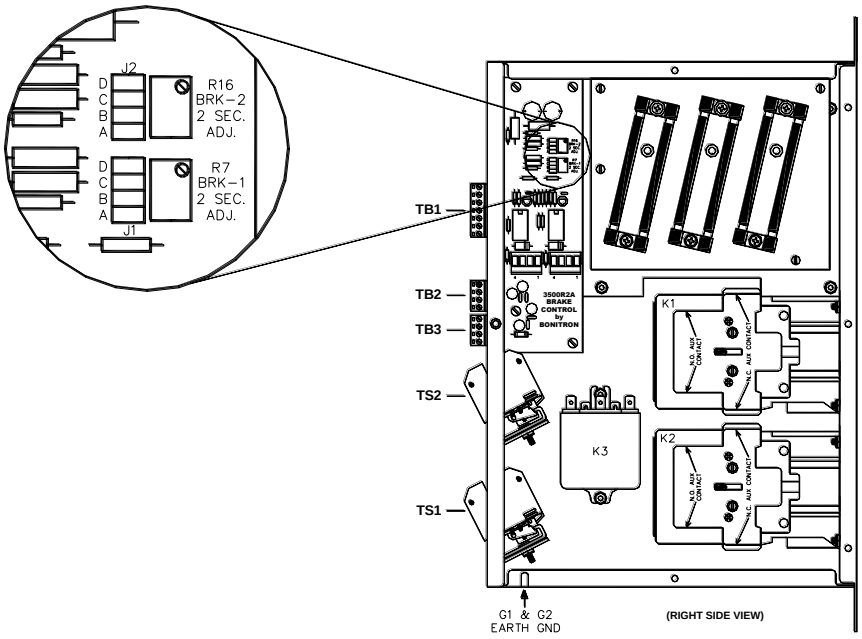
Refer to the illustration in Figures 4-1 and 4-2 for jumper and pot locations as well as jumper settings.

4.5.1. CALIBRATION FOR 32A AND 43A UNITS

- For safety class II modules (M3500DB), which have a single braking contactor, only the J1 jumpers and R7 adjustment pot will be used.
- For safety class IV modules (M3500DB4), which have redundant braking contactors, J1 and R7 will be used to set the delay for the BRAKE-1 input while the J2 jumpers and R16 adjustment pot will be used to set the delay for the BRAKE-2 input.

Since a change to the brake delay time does require that the side panel of the braking module be removed, brake delay adjustments should be made prior to installation whenever possible.

Figure 4-1: M3500DB(4) Brake Delay Jumpers & Adj. Pot Locations for 32A & 43A Units



CONTACTOR DROP–OUT DELAY
JUMPERS AND ADJUSTMENT POTS

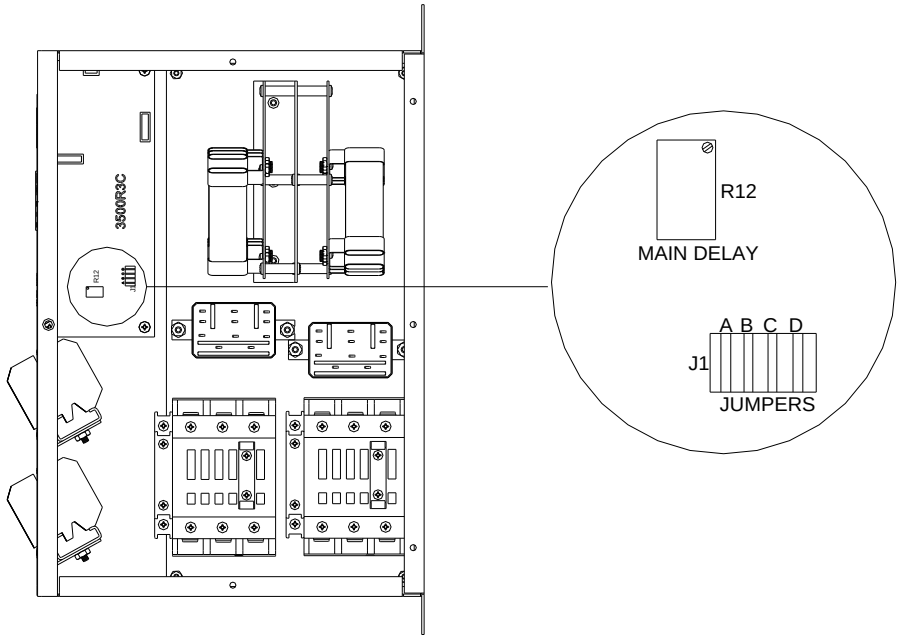
JUMPERS INSTALLED	DELAY TIME
NONE	NO DELAY
** A,B,C,D	0.5 SECONDS
A,B,C	1.0 SECONDS
A,B	1.5 SECONDS
A	2.0 SECONDS
** FACTORY DEFAULT SETTING	

Note: The module depicted in Figure 4-1 is the Model M3500DB4 Safety Class IV module. Jumper and adjustment pot locations are the same for the Model M3500DB Safety Class II module.

4.5.2. CALIBRATION FOR 65A UNITS

- Jumper J1 and Pot R12 on the ASB 3500R3 board are used to adjust the delay for the applicable BRAKE in the 65A units.

Figure 4-2: M3500DB Brake Delay Jumpers & Adjustment Pot Locations for 65A Units



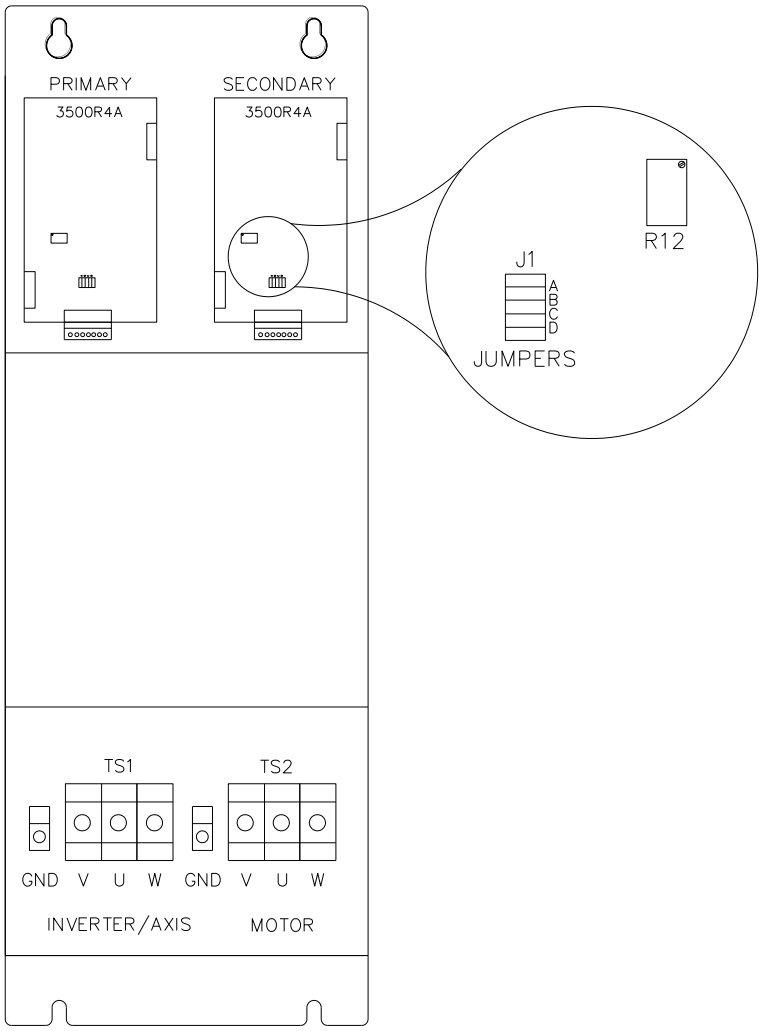
DELAY TIMES SHOWN ARE BASED
ON 24.OV DC BRAKE SIGNAL AT TB1

JUMPERS INSTALLED	DELAY TIME
NONE	NO DELAY
** A,B,C,D	0.5 SECONDS
A,B,C	1.0 SECONDS
A,B	1.5 SECONDS
A	2.0 SECONDS
** FACTORY DEFAULT SETTING	

4.5.3. CALIBRATION FOR 150A UNITS

- Jumper J1 and Pot R12 on the ASB 3500R4 board are used to adjust the delay for the applicable BRAKE in the 150A units.

Figure 4-3: M3500DB4 Brake Delay Jumpers & Adjustment Pot Locations for 150A Units



DELAY TIMES SHOWN ARE BASED
25,0V DC BRAKE SIGNAL AT TB1

JUMPERS INSTALLED	DELAY TIME
NONE	NO DELAY
** A,B,C,D	.05 SECONDS
A,B,C	1.0 SECONDS
A,B	1.5 SECONDS
A	2.0 SECONDS
** FACTORY DEFAULT SETTING	

5. MAINTENANCE AND TROUBLESHOOTING

Repairs or modifications to this equipment are to be performed by Bonitron approved personnel only. Any repair or modification to this equipment by personnel not approved by Bonitron will void any warranty remaining on this unit.

5.1. TECHNICAL HELP – BEFORE YOU CALL

If technical help is required, please have the following information available when contacting Bonitron (615-244-2825 Email:info@bonitron.com):

- Model number of unit
- Serial number of unit
- Time delay setting of unit and jumper configuration
- Motor type and hp or kW
- Name of original equipment supplier if available
- Brief description of the application

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6. ENGINEERING DATA

6.1. RATINGS CHARTS

Table 6-1: Available 32A Dynamic Safety Brake Modules

MODEL NUMBERS		PARAMETERS			
EN-954 SAFETY CATEGORY II	EN-954 SAFETY CATEGORY IV	FLA	LOAD	AUX. REPORT CONTACT STATE	BRAKE SIGNAL I/O HANDLING
M3500DB-H01A-32	M3500DB4-H01A-32	32 A	1Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H01B-32	M3500DB4-H01B-32			Normally Open	
M3500DB-H01A-32X	M3500DB4-H01A-32X			Normally Closed	Switching via aux. contact
M3500DB-H01B-32X	M3500DB4-H01B-32X			Normally Open	
M3500DB-H03A-32	M3500DB4-H03A-32		3Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H03B-32	M3500DB4-H03B-32			Normally Open	
M3500DB-H03A-32X	M3500DB4-H03A-32X			Normally Closed	Switching via aux. contact
M3500DB-H03B-32X	M3500DB4-H03B-32X			Normally Open	
M3500DB-H06A-32	M3500DB4-H06A-32		6Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H06B-32	M3500DB4-H06B-32			Normally Open	
M3500DB-H06A-32X	M3500DB4-H06A-32X			Normally Closed	Switching via aux. contact
M3500DB-H06B-32X	M3500DB4-H06B-32X			Normally Open	
M3500DB-H16A-32	M3500DB4-H16A-32		16Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H16B-32	M3500DB4-H16B-32			Normally Open	
M3500DB-H16A-32X	M3500DB4-H16A-32X			Normally Closed	Switching via aux. contact
M3500DB-H16B-32X	M3500DB4-H16B-32X			Normally Open	
M3500DB-H36A-32	M3500DB4-H36A-32		36Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H36B-32	M3500DB4-H36B-32			Normally Open	
M3500DB-H36A-32X	M3500DB4-H36A-32X			Normally Closed	Switching via aux. contact
M3500DB-H36B-32X	M3500DB4-H36B-32X			Normally Open	

Table 6-2: Available 43A Dynamic Safety Brake Modules

MODEL NUMBERS		PARAMETERS			
EN-954 SAFETY CATEGORY II	EN-954 SAFETY CATEGORY IV	FLA	LOAD	AUX. REPORT CONTACT STATE	BRAKE SIGNAL I/O HANDLING
M3500DB-H01A-43	M3500DB4-H01A-43	43 A	1Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H01B-43	M3500DB4-H01B-43			Normally Open	
M3500DB-H03A-43	M3500DB4-H03A-43		3Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H03B-43	M3500DB4-H03B-43			Normally Open	

Table 6-3: Available 65A Dynamic Safety Brake Modules

PARAMETERS				
EN-954 SAFETY CATEGORY II	FLA	LOAD	AUX. REPORT CONTACT STATE	BRAKE SIGNAL I/O HANDLING
M3500DB-H0.5A-65	65 A	0.5Ω	Normally Closed	Not Available
M3500DB-H1.5A-65		1.5Ω	Normally Closed	
M3500DB-H03A-65		3.0Ω	Normally Closed	

Table 6-4: Available 150A Dynamic Safety Brake Modules

MODEL NUMBERS	PARAMETERS			
EN-954 SAFETY CATEGORY IV	FLA	LOAD	AUX. REPORT CONTACT STATE	BRAKE SIGNAL I/O HANDLING
M3500DB4-H0.25A-150	150 A	0.25Ω	Normally Closed	Not Available
M3500DB4-H0.75A-150		0.75Ω	Normally Closed	
M3500DB4-H1.5A-150		1.5Ω	Normally Closed	

6.2. ELECTRICAL SPECIFICATIONS

Table 6-5: Control Signal Specifications for 32A & 43A Units

CONTROL SIGNALS (20-28VDC)	INRUSH CURRENT AT 24VDC	HOLDING CURRENT AT 24VDC	IMPEDANCE	OFF TIME DELAY
Enable-1	0.5 A	0.5 A	50 Ω	None
Brake-1	0.25 A	0.05 A	500 Ω	0 – 2 sec.
Enable-2	0.37 A	0.37 A	65 Ω	None
Brake-2	0.25 A	0.05 A	500 Ω	0 – 2 sec.

Table 6-6: Control Signal Specifications for 65A Units

CONTROL SIGNALS (20-28VDC)	INRUSH CURRENT AT 24VDC	HOLDING CURRENT AT 24VDC	IMPEDANCE	OFF TIME DELAY
Enable	7.5 A	500 mA	50 Ω	2 sec
Brake	100 mA	50 mA	500 Ω	0 – 2 sec.

Table 6-7: Control Signal Specifications for 150 Amp Units

CONTROL SIGNALS (20-28VDC)	INRUSH CURRENT AT 24VDC	HOLDING CURRENT AT 24VDC	IMPEDANCE	OFF TIME DELAY
Enable	3 A	1 A	50 Ω	2 sec
Brake	100 mA	50 mA	500 Ω	0 – 2 sec.

Table 6-8: Auxiliary Contacts

PARAMETER	SPECIFICATION
Continuous Thermal Current	A600 - 10A Q600 - 2.5A
Max VA/Amps Making	A600 - 7200 VA / 60A Q600 - 69 VA
Max VA/Amps Breaking	A600 - 720 VA / 6A Q600 - 69 VA
Max Operating Voltage	A600 - 600VAC Q600 - 600VDC

Note: For DC ratings at 600V or less, the make and break ratings shall be obtained by dividing the volt-ampere rating by the application voltage but shall not exceed the continuous carrying current.

Table 6-9: Braking Loads (ENABLE-1, BRAKE-1)

PARAMETER	SPECIFICATION
Duty Cycle	No more than 3 full load E-Stop conditions per minute per hour
Resistance	Rated load +/- 10% per leg, WYE configuration

Table 6-10: Motor Brake/Thermal Signal Conditioning (B1, B2, K1, K2)①

PARAMETER	SPECIFICATION
LC Filtering	47µH, 1µF each signal
Transient suppression	30V TVS between B1,B2
Max Ratings	28V DC at 2A

① Not included in 65A and 150A units.

Table 6-11: Control Inputs - Max Operations

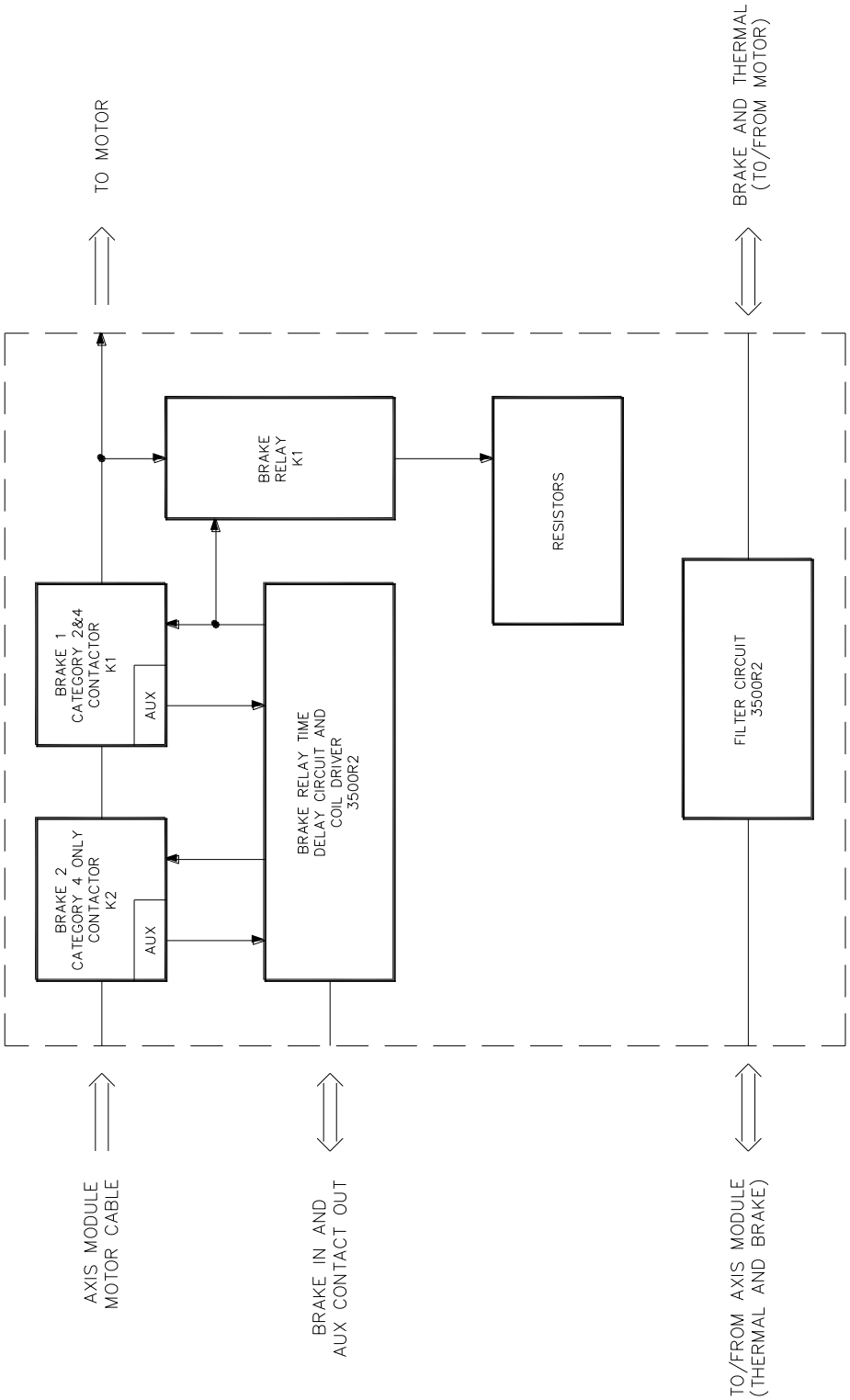
PARAMETER	SPECIFICATION
PRIMARY CIRCUIT (ENABLE-1/BRAKE-1)	
Full Load	No more than 3 full load E-Stop conditions per minute per hour
No Load	1200 operations per hour
SECONDARY CIRCUIT (ENABLE-2/BRAKE-2)	
Full Load	1200 operations per hour
No Load	1200 operations per hour

6.3. THERMAL AND HEAT DISSIPATION

For most applications, heat will only be generated during emergency stop situations and the maximum heat generated by these braking modules is 10kJ per hour.

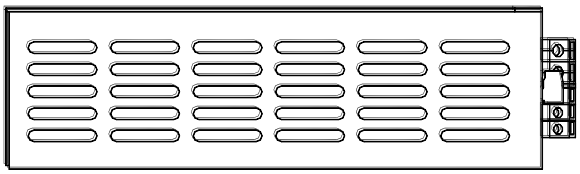
6.4. BLOCK DIAGRAM

Figure 6-1: M3500DB Basic Block Diagram



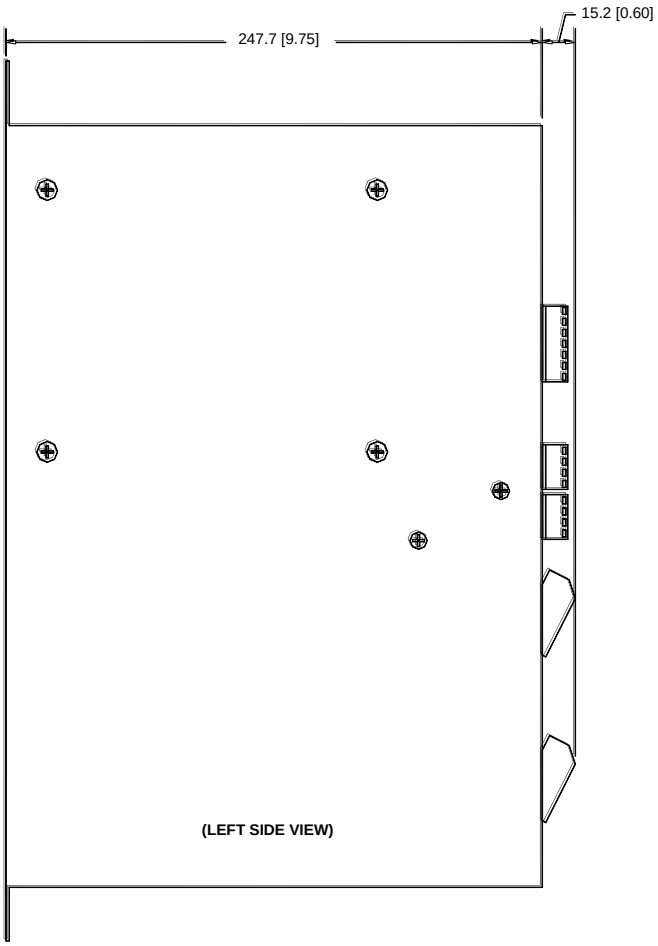
6.5. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-2: Dimensional Outline for the 32A & 43A M3500DB(4)

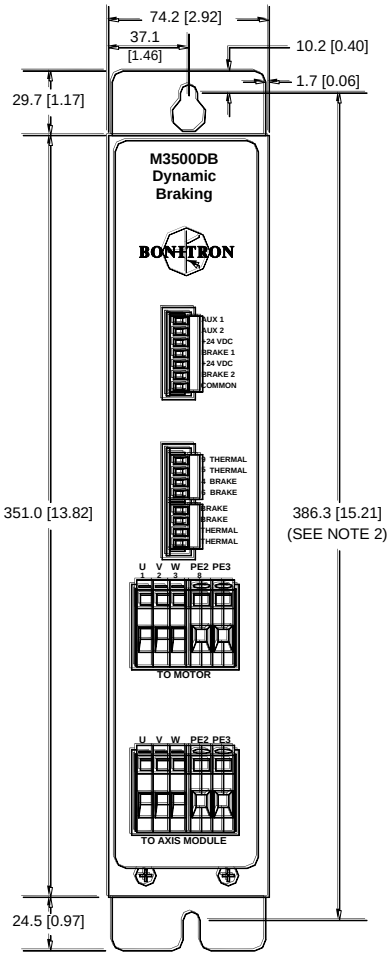


(TOP VIEW)

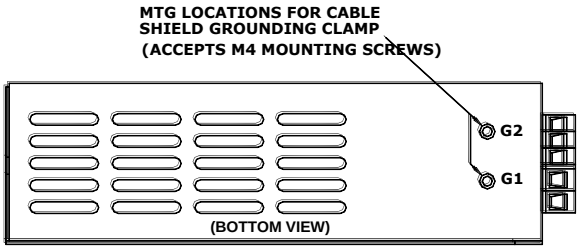
NOTES:
1) DIMENSIONS ARE IN MILLIMETERS [INCHES]
2) DIMENSION SHOWN IS FOR MOUNTING HARDWARE LOCATION AND DOES NOT REFLECT THE LOCATION OF THE BOTTOM SLOT RADIUS.



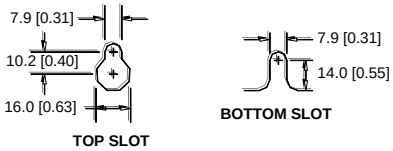
(LEFT SIDE VIEW)



(FRONT VIEW)



(BOTTOM VIEW)



TOP SLOT

BOTTOM SLOT

SLOTS ACCEPT M6 OR 1/4-20 MOUNTING SCREWS

Figure 6-3: Dimensional Outline for the 65A M3500DB

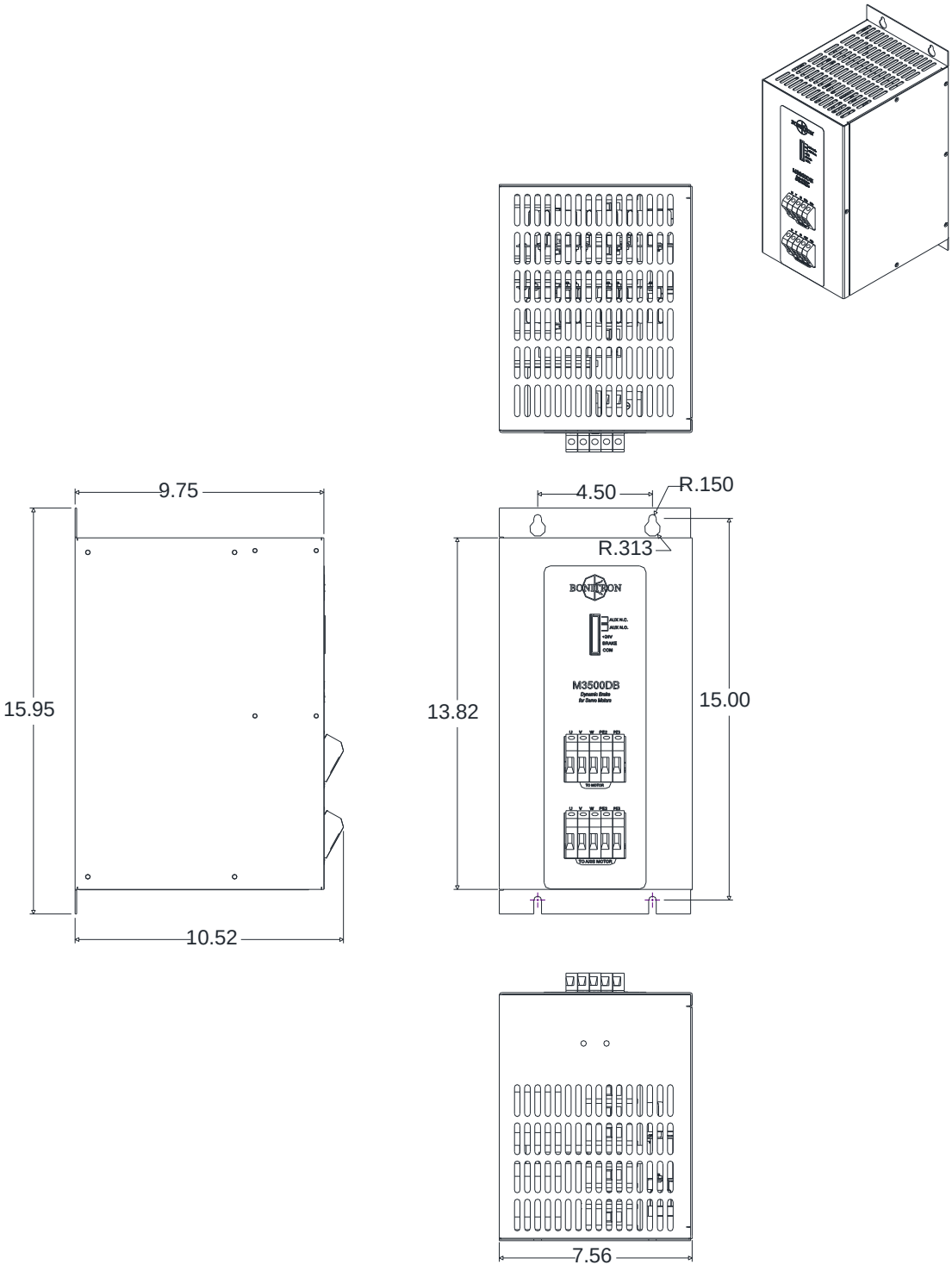
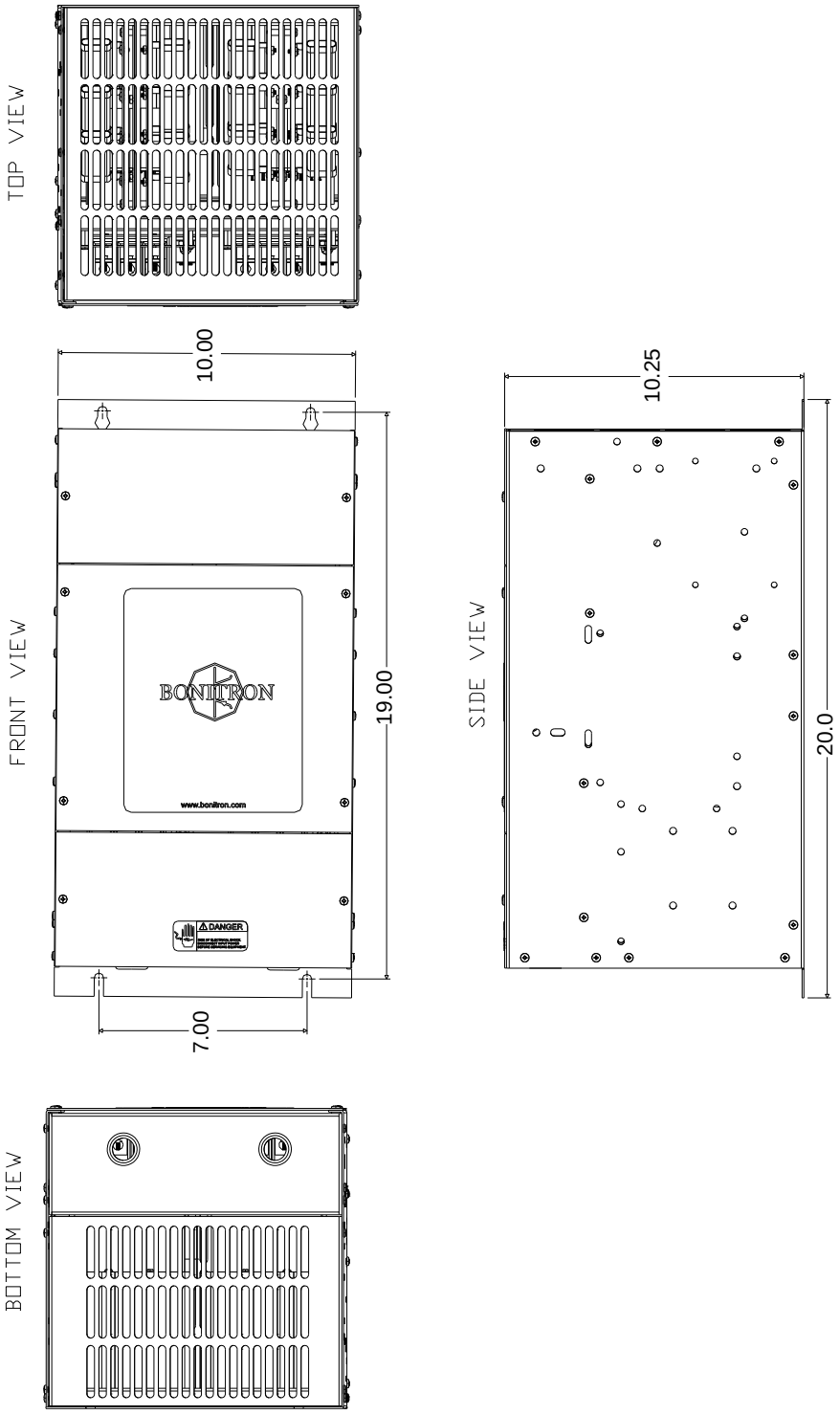


Figure 6-4: Dimensional Outline for the 150A M3500DB4



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7. APPENDICES

7.1. APPLICATION NOTES

It is very important to properly size the module to the application. The two main pieces of data are the full load current of the motor during normal operation and the resistance. The full load current of the motor will determine the size contactors required. The M3500DB modules are rated for maximum full load current. If the motor exceeds the rating of the module, use the next larger M3500DB module.

The resistance of the module determines the stopping time of the system. It must also be compatible with the winding impedance of the motor.

The stopping time and torque can be calculated from this resistance.

The best, and usually only, source of information for this resistance is the motor manufacturer and/or motion control simulation software provided by the drive manufacturers.

Bonitron provides some selection criteria for the motors in Tables 7-1 thru 7-8, but this data should be checked during the engineering and specification of the system with the drive and motor manufacturers for compatibility and application. For motors not listed, contact your motor or drive manufacturer for assistance.

7.2. MOTOR-TO-BRAKING MODULE CROSS REFERENCE TABLES

Table 7-1: 1326AB Series Motor To M3500DB(4) Cross Reference Table

1326AB SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
1326AB-B410G	18Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AB-B410J	12Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AB-B420E	6Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AB-B420H	6Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AB-B430E	4Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B430G	4Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B515E	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B515G	2.5Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B520E	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B520F	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B530E	2Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B720E	1.5Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-B720F	.8Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-B730E	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-B740C	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-B740E	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-C3E	1.0Ω	M3500DB-H01*-43	M3500DB4-H01*-43	1Ω

* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs. A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

Table 7-2: 1326AS Series Motor To M3500DB(4) Cross Reference Table

1326AS Series Motor Data		Bonitron DB Module		
Motor Type	Optimum Braking Resistance (Ohms per leg)	Part Number		DB Module Braking Resistance (Ohms per leg)
		EN-954 Class 2	EN-954 Class 4	
1326AS-B310H	36Ω	M3500DB-H36*	M3500DB4-H36*	36Ω
1326AS-B330H	23Ω	M3500DB-H36*	M3500DB4-H36*	36Ω
1326AS-B420G	16Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AS-B440G	10Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AS-B460F	9Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AS-B630F	11Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AS-B660E	6Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AS-B690E	4.5Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AS-B840E	4Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AS-B860C	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω

* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

Table 7-3: F Series Motor To M3500DB(4) Cross Reference Table

F Series Motor Data		Bonitron DB Module		
Motor Type	Optimum Braking Resistance (Ohms per leg)	Part Number		DB Module Braking Resistance (Ohms per leg)
		EN-954 Class 2	EN-954 Class 4	
F-4030-Q	2.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
F-4050-Q	1.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
F-4075-R	3.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
F-6100-R	0.75Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
F-6200-R	0.80Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
F-6300-R	0.25Ω	M3500DB-H01*	M3500DB4-H01*	1Ω

* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

Table 7-4: H Series Motor To M3500DB(4) Cross Reference Table

H SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
H-2005-K	0.50Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-3007-N	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-3016-N	1.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-4030-M	0.75Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-4030-P	2.0Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-4050-P	1.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-4075-R	1.50Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-6100-Q	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-6200-Q	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-6300-Q	0.25Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-8350-S	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-8500-S	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω

* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.

* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

Table 7-5: MPL-A Series Motor To M3500DB(4) Cross Reference Table

MPL-A Series Motor Data		Bonitron DB Module		
Motor Type	Optimum Braking Resistance (Ohms per leg)	Part Number		DB Module Braking Resistance (Ohms per leg)
		EN-954 Class 2	EN-954 Class 4	
MPL-A310F	13.25Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-A310P	11Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-A320H	6.5Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-A320P	5.75Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-A330P	3.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A420P	2.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A430H	2.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A430P	1.5Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
MPL-A4520K	3.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4520P	2.5Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4530F	3.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4530K	1.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4540C	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4540F	2Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A520K	2.5Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A540K	1.5Ω	M3500DB-H01*-43	M3500DB4-H01*-43	1Ω
MPL-A560K	1.25Ω	M3500DB-H01*-43	M3500DB4-H01*-43	1Ω

* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.

* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

Table 7-6: MPL-B Series Motor To M3500DB(4) Cross Reference Table

MPL-B Series Motor Data		Bonitron DB Module		
Motor Type	Optimum Braking Resistance (Ohms per leg)	Part Number		DB Module Braking Resistance (Ohms per leg)
		EN-954 Class 2	EN-954 Class 4	
MPL-B310P	50Ω	M3500DB-H36*	M3500DB4-H36*	36Ω
MPL-B320P	20.25Ω	M3500DB-H36*	M3500DB4-H36*	36Ω
MPL-B330P	13.5Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-B420P	10Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-B430P	6.5Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B4520P	10Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-B4530F	11.25Ω	M3500DB-H16*	M3500DB4-H06*	16Ω
MPL-B4530K	7.25Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B4540F	8.25Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B4540K	9Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B520K	11.25Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-B540K	5.75Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B560F	4.5Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B580J	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-B640F	3.5Ω	M3500DB-H03*-43	M3500DB4-H03*-43	3Ω
MPL-B660F	2.25Ω	M3500DB-H03*-43	M3500DB4-H03*-43	3Ω
MPL-B680D	2.5Ω	M3500DB-H03*-43	M3500DB4-H03*-43	3Ω
MPL-B680F	1.75Ω	M3500DB-H03*-65	Not Available	3Ω
MPL-B860D	2.25Ω	M3500DB-H03*-65	Not Available	3Ω
MPL-B880C	2Ω	M3500DB-H03*-65	Not Available	3Ω
MPL-B960B	4.25Ω	M3500DB-H06*-65	Not Available	6Ω
MPL-B960C	2.5Ω	M3500DB-H03*-65	Not Available	3Ω
MPL-B960D	2.75Ω	M3500DB-H03*-65	Not Available	3Ω
MPL-B980B	3.75Ω	M3500DB-H03*-65	Not Available	3Ω
MPL-B980C	2.25Ω	M3500DB-H03*-65	Not Available	3Ω
MPL-B980D	2.25Ω	M3500DB-H03*-65	Not Available	3Ω

* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.

* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

Table 7-7: N Series Motor To M3500DB(4) Cross Reference Table

N Series Motor Data		Bonitron DB Module		
Motor Type	Optimum Braking Resistance (Ohms per leg)	Part Number		DB Module Braking Resistance (Ohms per leg)
		EN-954 Class 2	EN-954 Class 4	
N-2302-1	2.0Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-2304-1	4.0Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
N-3406-2	1.8Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-3412-2	5.0Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
N-4214-2	2.9Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-4220-2	2.0Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-5630-2	2.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-5637-2	2.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-5647-2	3.0Ω	M3500DB-H03*	M3500DB4-H03*	3Ω

* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.

* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

Table 7-8: Y Series Motor To M3500DB(4) Cross Reference Table

Y Series Motor Data		Bonitron DB Module		
Motor Type	Optimum Braking Resistance (Ohms per leg)	Part Number		DB Module Braking Resistance (Ohms per leg)
		EN-954 Class 2	EN-954 Class 4	
Y-1002-1	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
Y-1002-2	1.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
Y-1003-1	0.25Ω	M3500DB-H01*	M3500DB4-H01	1Ω
Y-1003-2	1.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
Y-2006-1	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
Y-2006-2	1.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
Y-2012-1	1.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
Y-2012-2	5.0Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
Y-3023-2	2.5Ω	M3500DB-H03*	M3500DB4-H03*	3Ω

* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.

* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

7.1. DECELERATION TIME CALCULATION FOR SERVO MOTORS

The deceleration time can be calculated given certain properties of the motor and braking unit. The time can be calculated through the equation (1):

$$t = -ln\left(\frac{\omega_f}{\omega_\theta}\right) * \frac{104.7 * R * J}{k_e * k_t}$$

Where:

- t is the elapsed time (seconds).
- ω_f is the final velocity of the motor
- ω_θ is the initial angular velocity of the motor

Ex: For time required to slow initial rotational velocity to 5% of operation speed, $\frac{\omega_f}{\omega_\theta}$=0.05

- 104.7 is the conversion factor to convert k_e from KRPM to radians/ second.
- k_e is the motor voltage constant (Volts/KRPM).
- k_t is the motor torque constant (lb*in/Amp).
- J is the total system inertia (motor inertia + reflected load inertia).
- R is the total dynamic braking resistance (motor armature + cables + resistors)

R is calculated by summing the equivalent resistance of the braking resistors with the cables and the armature resistance as in the following equation (2):

$$R = (2 * R_{db}) + R_{ma} + R_{mc}$$

Where:

- R is the total dynamic braking resistance.
- R_{db} is the resistance in a leg of the braking resistor.
- R_{ma} is the motor armature resistance .
- R_{mc} is the motor cable resistance .

For example:

- R_{db} = 0.845 Ohms
- R_{ma} = 0.23 Ohms
- R_{mc} = 0.25 Ohms

$$R = (2 * R_{db}) + R_{ma} + R_{mc}$$

R = (2*0.845) + 0.23 + 0.25 = 2.17 Ohms

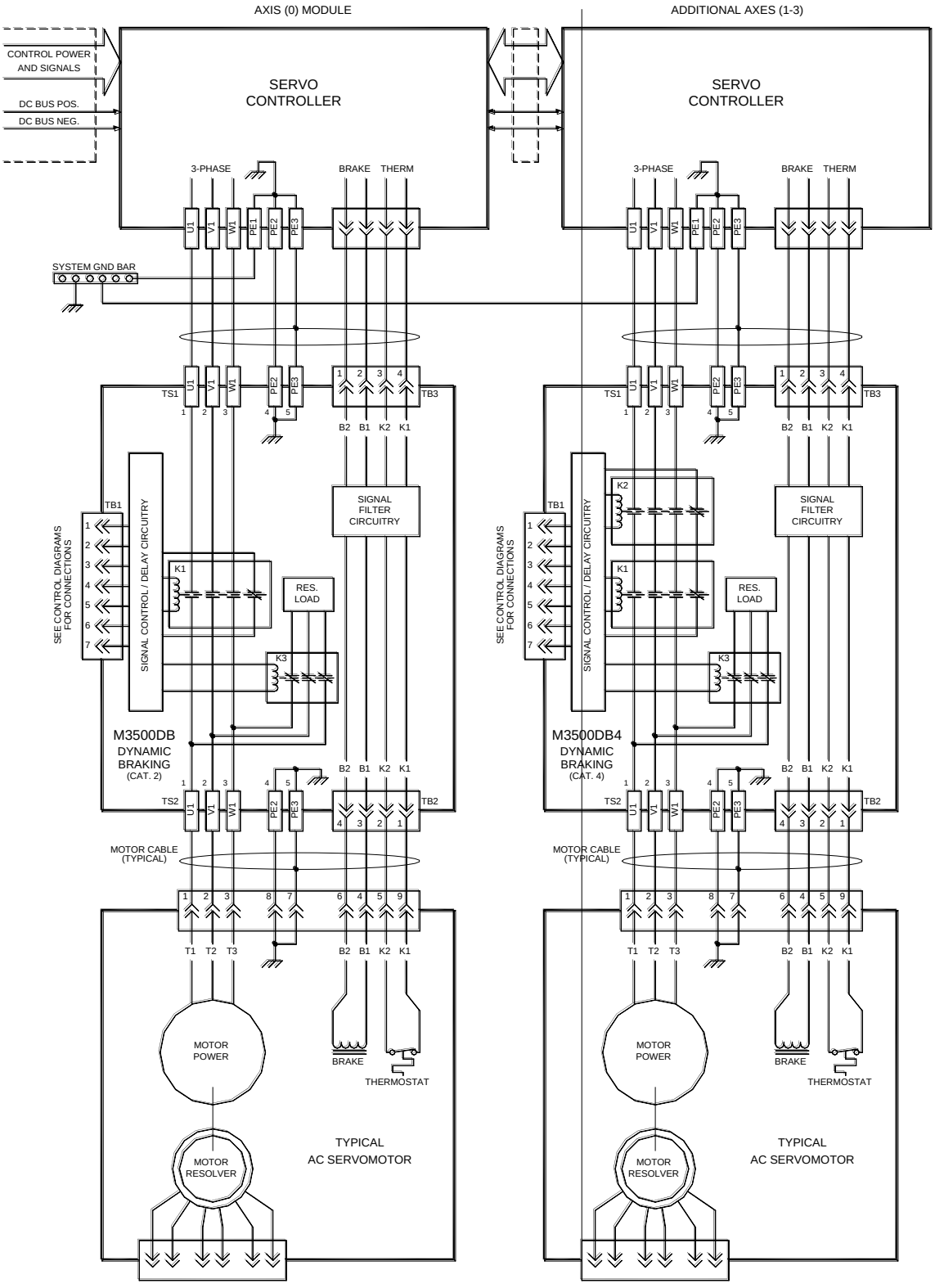
Given the values:

- $\frac{\omega_f}{\omega_\theta}$ = 0.05
- k_e = 136.2 V/KRPM
- k_t = 19.9 lb*in/Amp
- J = 0.5044 lb*in/sec²
- R = 2.17 Ohms

We plug these into equation (1) to get:

$$t = -ln(.05) * \frac{104.7 * 2.17 * 0.544}{136.2 * 19.9} = 0.127\ s$$

Figure 7-1: M3500DB and M3500DB4 Dynamic Safety Brake Field Interconnection



NOTES

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